ELECTRICITY-ELECTRONICS

ELECTRICITY

ELECTRONICS

12, 12A
22A, 22B, 22C
32A, 32B, 32C

Interim Edition

1972

Department of Education

Government of Alberta

A C K N O W L E D G M E N T S

The Department of Education acknowledges with appreciation the contribution of the following Ad Hoc Committee members to the preparation of this Guide.

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NOTE: <u>This Curriculum Guide is a service publication only</u>. The Senior High School Program of Studies contains the official statement concerning Senior High School Drafting. The information contained in the Guide is prescriptive insofar as it duplicates that contained in the Program of Studies. There are in the Guide, however, as well as content, methods of developing the concepts, suggestions for the use of teaching aids and lists of additional reference books.

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I. INDUSTRIAL EDUCATION

Industrial Education is a program consisting of courses which provide a continuum of experiences, starting with exploratory activities in the junior high school and expanding in the high school to the development of skills related to career fields. This development of the student's skills is planned for through courses in Industrial Arts and Vocational Education culminating in on-the-job work experience, or entry into a job or post-high school institution for further education.

The program consists of courses ranging from those designed for an exploration of the technologies and trade areas to units of practical preparation for a career. In the process the courses develop the student's knowledge of himself, his talents and his skills.

The Industrial Education course "guides" provide the teacher with an outline of the topics, generalizations and concepts selected as most relevant for the physical and mental development of the students and the logical development of the subject area in accordance with the resources of the school in both teaching personnel and facilities.

The Guide leaves much scope for the teacher to develop content related to the topics, especially in writing behavioral objectives describing specific changes in student behavior anticipated from the learning tasks.

It is expected that each school district will develop a program of Industrial Education appropriate to the fulfilment of the needs of its student clientele.

II. OBJECTIVES

A. Industrial Education Objectives

The general objectives of Industrial Education complement the aims and objectives of the secondary school. The objectives of Industrial Education are to:

1. Develop basic competencies both academically and in work skills to enter either a job or a post-high school institution for further education.

2. Provide courses that serve as a vehicle in helping students relate their academic knowledge to vocational competencies.

3. Provide the curriculum content for students to develop fundamental tool and procedural skills which prepare them to enter a family of occupations.

4. Provide the environment whereby students may develop sound attitudes and habits of work.

B. Electricity-Electronics Career Field Objectives

The Electricity-Electronics career field should provide a student an opportunity to:

1. Gain an understanding of the career field.

2. Develop skills and knowledge necessary for job entry or articulation with post-high school institutions.

3. Develop and strive to achieve standards of performance acceptable to the industry.

C. Major Area of Study Objectives

The specific objectives of the major area of study such as Automotives etc., must be developed by the teacher in harmony with the stated objectives of the career field, the Industrial Education program and the secondary school.

III. EVALUATION

Evaluation of student growth should be based on stated behavioral changes and specific criteria understood by the students. Allowance should be made for both self and teacher evaluation and in some cases peer evaluation. Evaluation should further be based on the three domains of learning as defined by an Alberta committee of Industrial Education teachers. Their categories are as follows:

a. Verbal and Written Communication

b. Personal Growth

c. Manipulative Skills

The weighting given each of the three measures will depend on the nature of the behavior being evaluated. For a more detailed treatment of evaluation see the Industrial Education Handbook.

IV. ORGANIZATION

A. Guide Organization

The course Guides are developed on the following pattern:

1. Topic: Each course is subdivided into a number of topics.

2. Generalization: The main generalization or "big" idea that students should learn follows each topic.

3. Concepts: The concepts divide the topic into the teaching components. They give more direction on specific areas that should be studied.

4. Behavioral Objectives: These describe specific changes in student behavior which result from learning tasks he performs.

   The Guide gives only a few sample behavioral objectives. It is the responsibility of the teacher to develop as many behavioral objectives as he can teach in the time available.

5. Suggested Activities: A few suggestions are made as to the types of activities that could be used to achieve the behavioral objectives.

6. Resource Materials: This column suggests where materials may be obtained.

B. Program Organization

1. Program Description

   The Electricity-Electronics modules give students the opportunity to learn the theory and skills necessary in the trade. They will learn to identify and use the

tools of the trade to perform the major tasks related to the installation, servicing and repair of electrical products. Their activities may range from experimental work to installing and repairing equipment. In the process they will learn about the trade, job opportunities, business practices, and enough skills to get a job, go into apprenticeship or enhance their avocational interests.

2. Program Major Organization

The major is divided into seven five-credit modules. Two of these are common to both majors. Entry into the major is through Electricity-Electronics 12 or General Technology 10. The modules in Electricity are open to 32B, for which 22A is a pre-requisite. In Electronics, 22A is pre-requisite to 22B, 22C and 32B. Also 22C is pre-requisite to 32B.

Except for the Digital Logic course, 32C is the last course in the 35 credit sequence and can be used to:

a. provide greater depth to a module taken previously.

b. gain experience in actual construction under a work plan whereby the Electricity-Electronics teacher coordinates the student's program. The student must be under the supervision of a journeyman or tradesman while on the job.

In addition to the modules set out in the major for Electricity-Electronics a student may select modules designated as minors. These are normally the first level or introductory course of the area, e.g. the module in Automotives would be Mechanics 12.

A student wishing to meet the requirements of the Apprenticeship Branch must complete all seven modules in the major area.

Some students, however, may take only a few modules in a major area as a supplement to their academic program or they may broaden their selection to other career fields. The scope of the Industrial Education program allows the flexibility necessary for the program to be tailored to meet the interests and needs of the individual class or student.

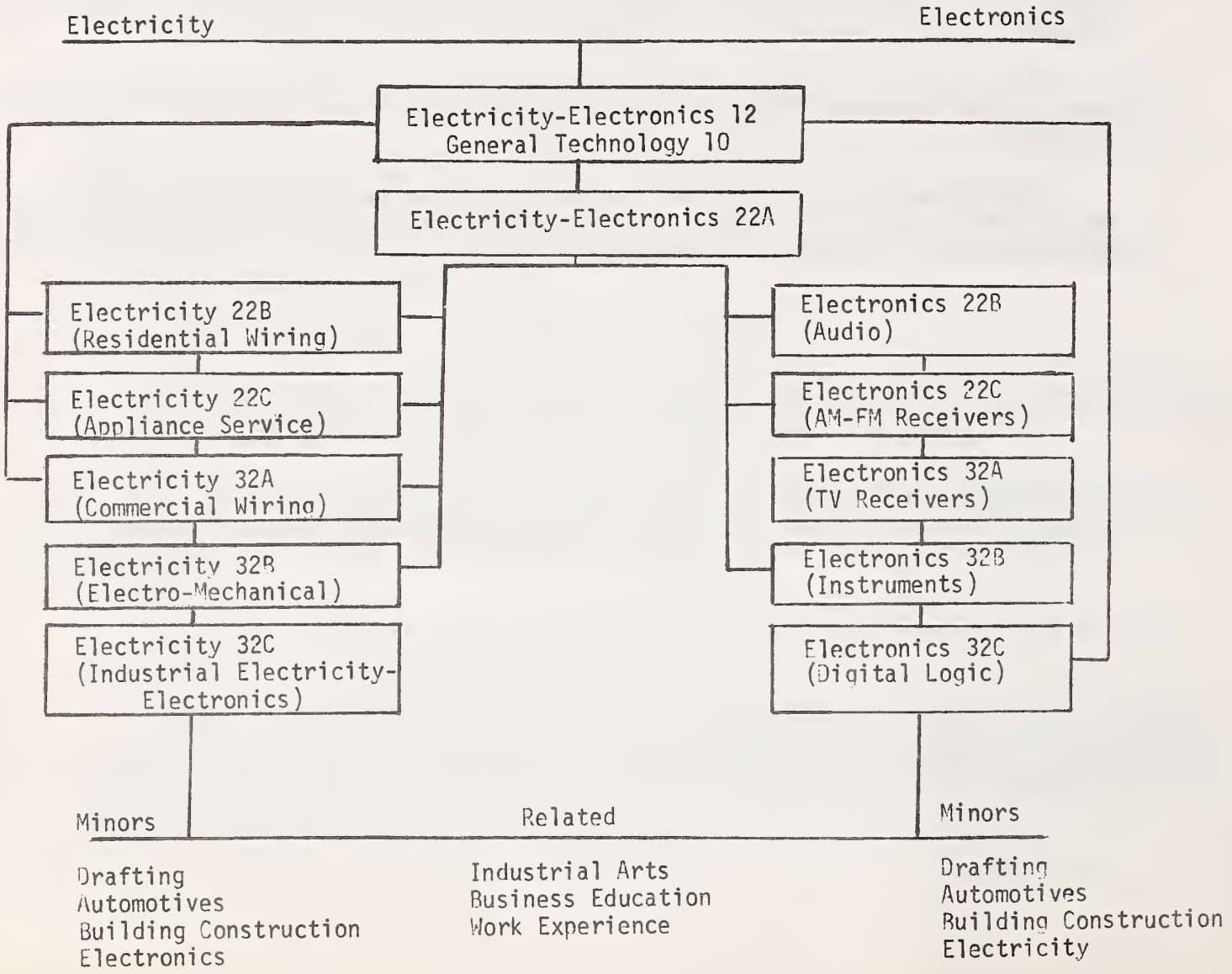
The chart on Page 6 gives a graphic description of the Electricity-Electronics program. Each module is identified and the sequences are indicated by lines, e.g. after a student has completed one of Electricity-Electronics 12 or General Technology 10 he/she may advance to any module to which the solid line leads. In the case of Electricity he may advance to 22B, 22C or 32A. In the case of Electronics he may advance to 32C (Digital Logic) or 22A. In Module 32C all modules before it must be completed if it is to be used for in-depth study.

Once a student has enroled in a "22" or second level course he may also select modules from the minor fields. Minors for which grants are available are listed on the chart.

Students may find some of the courses in the listed related fields beneficial to their career program development. They are encouraged to take them even though these related courses are not supported by special grants.

CAREER FIELD

ELECTRICITY-ELECTRONICS



V. CAREER OPPORTUNITIES

Students taking all or most of the modules in the Electricity or Electronics major may look forward to the following poortunities:

A. Electricity (35 credits)

Post-High School Studies

N.A.I.T. or S.A.I.T.

- Electrical Technology
- Telecommunications Technology
- Air Conditioning & Refrigeration
- Electrical Engineering Technology

UNIVERSITY

- Engineering
- Education

Career Entry

- Apprenticeship
- Journeyman Electrician
- Appliance Serviceman
- Power Electrician
- Foreman
- Shop Owner

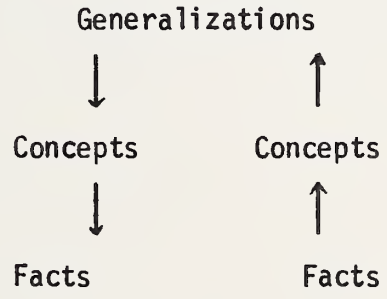
→ Engineer, Teacher

B. Electronics (35 credits)

Post-High School Studies	Career Entry
N.A.I.T. or S.A.I.T.	Apprenticeship
Electronic Technician Electronics Technology Electronic Engineering Technician (Broadcasting) (Communications) (Industrial)	Radio & Television Technician Electrical Mechanic Telephone Power Electrician Instrument Mechanic
UNIVERSITY	
Engineering Education →	Engineer Teacher

Note:

As a result of variation in levels of practicality or abstraction in the "concepts" and "generalizations" identified for this course as compared with others, these expressions may appear to be used somewhat differently from course to course. However, it is the intent of the curriculum developers to maintain a consistent interpretation. The diagram below may help to explain the relationship.



Facts are taken to be items of specific information, concepts are categories of information and generalizations express the relationship between concepts.

In planning a lesson, the teacher moves down this hierarchy whereas in learning, the student begins with facts and moves upward.

VI. ELECTRICITY-ELECTRONICS

1. Electricity-Electronics 12 and 12A

INTRODUCTION

The general objectives of this course are to provide exploratory experiences for the student to acquaint him with opportunities for employment; to provide orientation to a technical and industrial environment; to provide opportunities for leisure and recreation; to provide concrete applications of academic concepts and principles; to aid him in the choice of a vocation; to provide some necessary background for Electricity 22 and to develop an understanding of man's changing role in a technologically advancing society.

The introductory Electricity-Electronics 10 and 12 is a five-credit course. The Electricity-Electronics 12A course consists of content selected from the 12 course and is equivalent to 2 1/2 credits or 65 hours in time. The 12A is one component of the General Technology course and must be paired with another 12A course; e.g. Drafting 12A, Photo Print 12A, Building Construction 12A, Auto 12A to form a prerequisite for the 22 course.

REFERENCES AND RESOURCE MATERIALS

No one text is prescribed, however, those marked * are considered most valuable as such.

* Buban, Schmitt, Kirchner. *Electricity and Electronics.* Toronto, Ontario: McGraw-Hill Company of Canada Ltd.

* Marcus, Abraham. *Basic Electricity, 2nd edition.* Englewood Cliffs, N. J.: Prentice-Hall Inc.

* Long, F. *Intermediate Electricity.* Don Mills, Ontario: General Publishing Co., 1965.

* Schick, Kurt. *Elements of Electricity and Electronics.* Toronto, Ontario: McGraw-Hill Company of Canada Ltd.

Van Valkenburgh. *Basic Electricity.* New York: Nooger & Neville, Inc. and John F. Rider Publisher, Inc.

Gerrish, Howard H. *Transistor Electronics.* South Holland, Illinois, U.S.A.: The Goodheart-Wilcox Co. Inc.

Miller, Rex, Fred W. Culpepper Jr. *Energy, Electricity and Electronics.* Illinois, U.S.A.: McKnight & McKnight Publishing Company, 1964.

Boer, C. J. *Electricity and Electronic Drafting, 2nd edition.* Toronto, Ontario: McGraw-Hill Company of Canada Ltd.

No one single laboratory manual prescribed - some experiments may be extracted from *Basic Electricity* and *Basic Electronics* manuals by Zbar.

Career Field: Electricity-Electronics

Topic I: CAREER FIELD

Major: Electricity-Electronics

Generalization A: Occupational information and a knowledge of employment opportunities in the Electricity-Electronics career field will help the student determine his educational and vocational endeavors.

Course: Electricity-Electronics 12 and 12A

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Occupational Information		The student will:		
(i.) Awareness of employment opportunities		a. search out job opportunities, basic requirements and determine his interest to help plan his high school program.	Discuss career field opportunities. Use occupational information and films to show types of careers available.	
(ii.) Future opportunities		b. given more information on course content, outline the vocation he would like to prepare for.	Discuss course content of courses that follow.	
		c. list the opportunities within a career field - installer, electrician, technician, technologist, engineer, mechanic, serviceman.		
(iii.) Articulation		d. explain how this course articulates with requirements of other institutions.	Discuss the technical and apprenticeship articulation.	

Notes:

Topic II: SAFETY AND FIRST AID

Generalization B: Safety is of prime importance to the well being of persons and the protection of equipment.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Unsafe Act		The student will:		
		a. list the consequences of unsafe acts in Electricity-Electronics as they relate particularly to: (i.) live circuits (ii.) amperage (iii.) proper grounding (iv.) protective clothing.	Discuss shop behavior and safety procedures to be observed.	
2. Unsafe Condition		b. discuss how to identify conditions which could lead to injuries on the job.		
3. Safety Standards and Codes - Federal - Provincial - Local		a. safety standards and codes as opportunities arise.	Perform experiments in compliance with the electrical code. Demonstrate procedure for face replacement, circuit breaker reset, thermo cutout reset. See Unsafe Acts and Conditions IAVEC - ATA Reference to publication on safety.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
4. First Aid		a. remove a person from a line and administer artificial respiration. b. treat a person for medical shock.	Discuss and show safety film. Practice several methods of artificial respiration, obtain safety demonstration films.	

Notes:

Topic III: ELECTRICITY

Generalization C: A knowledge of what electricity is, nature of its behavior and sources of it is basic to observing and understanding the electrical phenomenon.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Electricity		The student will:		
		a. define static and dynamic electricity and demonstrate the law of charges.	Charge pith balls, demonstrate and discuss their behavior.	
		b. describe the nature of a charge from the structure of the atom and charged atoms.		
		c. differentiate between static and dynamic electricity.	Demonstrate, measure and observe AC pattern on a scope.	
		d. define and differentiate between AC and DC.	Observe other waveforms-square etc.	
2. Sources of Electricity		a. given the necessary equipment demonstrate six basic sources of electricity and the nature of electrical energy produced - AC or DC.	Discuss, demonstrate and experiment with various sources of electricity.	

Notes:

Topic IV: CONDUCTORS AND INSULATORS

Generalization D: Control and behavior of current is determined by the nature and condition of current path.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Conductors		The student will: a. define conductors in terms of ease of current flow. b. define conductors in terms of atomic structure.	Set up demonstrations showing charge in current flows through different materials.	
2. Insulators		a. define insulators in terms of: (i.) ease of current flow (ii.) atomic structure. b. explain the different conductivity of different material conductors. c. discuss the effects of lengths, diameter, material and temperature on the conductivity of conductors.	Demonstrate the effects on current flow of different lengths, diameters and nature of material of conductors.	
3. Semiconductors		a. distinguish among conductors, semiconductors and insulators in terms of: (i.) ease of current flow (ii.) atomic structure-number of electronics in outer orbit.	Using models of atomic structure or diagrams, show the atomic structure of conductors, semiconductors and insulators.	

Notes:

Topic V: MAGNETISM AND ELECTROMAGNETISM

Generalization E: Magnetism and electromagnetism are basic to motor action, induction and generator action.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Magnetism		The student will: a. explain why a bar can be magnetized: (i.) Electron Theory (ii.) Domain Theory.	Using an overhead projector and iron fillings with magnets, demonstrate: (1) magnetic field around a magnet (2) attraction-repulsion fields (3) motor action as a result of attraction or repulsion - applications, e.g. meter movement. Demonstrate - using left hand rule, rule and compasses.	
2. Motor Action		a. memorize the laws of attraction and repulsion. Explain:		
3. Electromagnetism - the magnetic effect of current		(i.) that associated with current there is a magnetic field (ii.) the polarity of this field can be determined by the Left Hand Rule. b. define an electromagnet and explain what determines its strength.	Discuss and show practical applications of electromagnets. Make electromagnets.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		c. determine the magnetic polarity of a current carrying coil.		
4. Induction		a. explain induction.		
		b. give examples of electro-magnetic induction-motor, generator, transformer.		
5. Generator Action		a. acquire knowledge and understanding of generator action.	Demonstrate and discuss generator action of a coil rotating in a magnetic field.	

Notes:

Topic VI: ELECTRICAL UNITS AND MEASUREMENT

Generalization F: The volt, ohm ampere and watt are basic in component and circuit measurements.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Volt - Unit of Electrical Pressure		The student will: a. use a volt-meter to measure voltage (Potential difference, emf, electrical pressure). b. correctly use a volt-meter.	Measure the voltage of cells, cells in series and parallel as power supplies and batteries measure variable power supply outputs and voltage drops.	
2. Ohm - Unit of electrical resistance or opposition		a. demonstrate: (i.) how to use an ohmmeter and read color coding of resistors (ii.) how to prolong the life of an ohmmeter (iii.) how to use an ohmmeter as a continuity checker.	Select various resistors, determine rated value and then measure their value with an ohmmeter.	
3. Ampere - Unit of electrical current flow		a. use an ammeter to measure current flow and precautions to be observed to safeguard the ammeter. b. define an ampere as a Coulomb per second.	Experiment with circuits with different amounts of current flow.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
4. Watt - Unit of electrical power		a. use and identify a wattmeter and study its hook-up.	Demonstrate hook-up and measurement of wattage of lamps, resistors and loads in electrical circuits.	
		b. read the power consumed on a commercial wattmeter.	Read the domestic wattmeter at home over an interval of time. Find out cost of power and calculate cost of consumption over this interval of time.	

Notes:

Topic VII: ELECTRIC CIRCUIT

Generalization G: The basic parts of an electrical circuit, their arrangement and condition of current path governs operational conditions of the circuit by certain relationships.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Basic circuit - has four main parts		The student will: a. name the main parts of an electrical circuit and give the function of each part. Source, conductors, load, control device.		
2. Types of Circuits		a. differentiate and demonstrate the types of electrical circuits, e.g. series, parallel, complex. b. define: (1) series (2) parallel (3) complex circuits in terms of number of current paths. c. sketch and define an open circuit and a short circuit. d. with the aid of a schematic diagram, determine circuit operation or non-operation.	Set up different kinds of circuits using open wire circuitry to demonstrate and compare differences in circuit component arrangements and paths for current to follow. Examine various circuit conditions with open, closed or shorted circuitry.	

Notes:

Topic VIII: ELECTRICAL COMPONENTS

Generalization H: Electrical components are represented by symbols that become schematic diagrams.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Symbols		The student will:		
		a. draw circuit diagrams given the symbols of the parts and components.	Distinguish components and draw their symbols.	
		b. read and explain the component arrangements in the circuit by using a schematic diagram, e.g. series, parallel, etc.	Using some basic components, wire a circuit from a schematic.	
2. Schematics		a. given an electrical circuit, draw a schematic diagram of it.	Draw schematic diagrams from given circuits.	
3. Diagrams		a. identify the following types of diagrams and explain their uses: (i.) pictorial (ii.) floor plan (iii.) schematic (block).	Illustrate and discuss advantages, uses and limitation of electrical diagrams of various type.	

Notes:

Topic IX: ELECTRICAL LAWS

Generalization I: Electrical circuits are governed by electrical laws and expressed in formulas.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Ohm's Law		The student will:		
		a. explain the effect on the current in a circuit if the resistance is varied (voltage constant), and effect on current with voltage varied if resistance is constant.	Set up experiments to demonstrate the effects on the current of varying E or R. Experiment #8, 9 (Zbar, *Electricity*).	
		b. using Ohm's law calculate the current, voltage or resistance in electrical circuits. $I = \frac{E}{R}$		
2. Power		a. define and calculate power consumption or dissipation by using the power formulas: $P = EI$, $P = I^2R$, $P = \frac{E^2}{R}$	Discuss, demonstrate and calculate the wattage of electrical components.	
(i.) Series Circuits		b. memorize that: (i.) I is the common component $I_t = I_1 = I_2$, etc. (ii.) Total resistance is the sum of the resistors $R_t = R_1 + R_2 + R_3$,etc. (iii.) Sum of the voltage drops= applied voltage $E_t = E_1 + E_2 + E_3$, etc.	Experiment #10 or equivalent (Zbar, *Electricity*).	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
(ii.) Parallel Circuits		c. memorize that: (i.) E is the common component (ii.) Total line current is the sum of the branch currents $I_t = I_1 + I_2 + I_3$, etc. (iii.) Total resistance is the sum of the reciprical $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$, etc.	Experiment #11 or equivalent.	
(iii.) Complex Circuits		d. identify similarities of both series and parallel circuits and their relationship within one circuit.	Experiment #12 or equivalent.	
3. Kirchhoff's Laws		a. interpret and explain Kirchhoff's Law of current and voltage. b. differentiate these laws as they apply to series and parallel circuits.	Experiment #13 or equivalent.	

Notes:

Topic X: SOLDERING AND MAKING OF CONNECTIONS IN ELECTRICAL CIRCUITS

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Soldering		The student will: a. define soldering b. given the materials, solder them and avoid cold solder joints. c. make connections that are mechanically and electrically strong. d. apply the proper technique in un – soldering.	Make three common splices. Solder these splices, solder flat surfaces to flat surfaces, solder wire to flat surfaces. Solder hook-up wire or components to terminals and remove.	
2. Solderless connectors		a. given varying types of connectors, make solderless connections. b. do basic wiring using solderless connectors in series, parallel and series-parallel circuitry.	Make several connections using different types of solderless connectors. Using a working plank and open wire circuitry wire the following: (1) Series - 1 switch, 1 light, AC source (2) Parallel - 1 switch, 2 lights, AC source (3) Series-Parallel - 1 switch, 3 lights, AC source.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		c. use octagon boxes, switch boxes and proper code and wiring techniques. NOTE: With a symbolic and schematic idea of components, it is proposed that a more general approach to electrical-electronics systems be taken. This approach would start with a system and the units making up the system, their function within the system, and finally the components utilized. The function of the components within the units would then be studied as well as major troubles and faults with components.	Closed wire - House Wiring Circuits (1) Series (2) Parallel (3) Controlled light and hot outlet (4) 3-way, 2 switches, one light.	

Notes:

Topic XI: SYSTEMS STUDY

Generalization J: Electrical and Electronic systems incorporate many concepts to perform specific functions. Sum total of circuits working together to perform a specific function is a system.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Audio		Student should study a minimum of four of the systems outlined below. The student will:		
(i.) Transducers are necessary prior to amplification as well as after		a. convert sound waves to electrical waves prior to amplification.	Demonstration Microphones, headphones, speakers and phonopickups.	
		b. explain the basic theory of operation of a microphone, headphones and speakers.	Demonstration of a record player amplifier.	
(ii.) A Hi-Fi amplifier system employs several basic electronic units		c. explain the basic theory of operation of a Hi-Fi system and the function of each unit.	Set up a Hi-Fi stereo amplifier arrangement to use a record player, tape input, or some other input system.	
2. Electrical Distribution System		a. explain power distribution to substations.	Discuss and visit a substation. Explain use of and function of transformers and capacitor banks.	
(i.) Transformers		b. differentiate between the needs and hardware requirements in residential wiring.	Explain, discuss and tour the school facilities to point out different distribution arrangements. 110, 220 single phase, three phase.	

Notes:

Topic XI: SYSTEMS STUDY (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
3. Generating Plants		a. study the different methods of commercial production of electricity. b. observe the supporting and related occupations in power generation and distribution.	Discussion, Film or plant visitation.	
4. Broadcast Receiver (i.) Reception consists of interception, detection and amplification		a. with the aid of a block diagram, explain the function of each unit within the receiver system. b. trace the signal through the receiver system and compare inputs and outputs of the units.	Using a demonstration receiver and modular structure, demonstrate the function(s) of each unit of the receiver system. Draw and label a block diagram of a superhet receiver and show the waveforms at input and outputs and outputs of stages. Demonstrate the development of radio reception from a crystal detector to TRF to superhet.	

Notes:

 Topic XI: SYSTEMS STUDY (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
5. Broadcast Transmitter		a. explain the basic principles of establishing a carrier using the block diagram approach to a basic transmitter. b. explain that modulation is a process of modifying some characteristic of a carrier in accordance with intelligence. c. explain the function of each unit, inputs-outputs, principles of operation, energy transformation, transmission and wave propagation.	Using a demonstration transmitter, demonstrate a carrier and effects on it of a modulating signal. Draw a block diagram of a basic transmitter showing waveforms of inputs and outputs of the units in the system.	
Five other systems which could be studied: Electrical Appliance Electric Motor Digital Device Television Receiver				

Notes:

VI. ELECTRICITY-ELECTRONICS

2. Electricity- Electronics 22A

INTRODUCTION

Electricity-Electronics 22A is a module common to both the Electricity and Electronics majors. It is a pre-requisite to Electricity 32B and to Electronics 22B, 22C and 32B.

The course is designed to give the student sufficient skill and knowledge to be able to effectively achieve in subsequent courses in Electricity or Electronics.

REFERENCES

No one text is prescribed, however those marked * are considered most valuable as such.

* Miller, Rex and Culpepper, Fred W. Jr. *Energy, Electricity and Electronics.* McKnight & McKnight, Illinois, U.S.A. 1964

* Grob. *Basic Electronics.*

Malvino. *Transistor Approximations.*

Grob & Kiner. *Applications of Electronics.*

Kiner, Milton S. *Transistors.*

De France. *Communications Electronics Circuits.*

Veatch, H. *Transistor Circuit Action.*

De France. *General Electronic Circuits.*

Van Valkenburg, Nooger & Ninille, Inc. *Basic Electricity.* John F. Rider Publisher, Inc. N.Y.

Lister. *Electric Circuits and Machines.* 4th Ed. McGraw-Hill, Toronto.

Laboratory manuals:

Zbar. *Basic Electricity.* 3rd Ed.

Zbar. *Basic Electronics.* 3rd Ed.

Electricity-Electronics 22A

Note:

This is quite a heavy theory course. Some teachers may feel the need to transfer some of the content to the 22B module. In any event, students should be given a review of previous work under the following headings.

1. Safety.

2. Basic Concepts of Electricity.
   Electron theory, electrostatics, electrodynamics, emf, resistance-conductance, conductors and insulators, use and care of meters, sources of emf, electrical units, AC and DC.

3. Basic Circuits.
   Review series circuits, parallel circuits, complex circuits, Ohm's Law, energy and power, Kirchhoff's Laws, voltage dividers.

4. Magnetism and Electromagnetism.
   History, natural and artificial, permanent and temporary, magnetic polarity, magnetic fields, laws of magnets, magnetic effect of current, electromagnets.

5. Electromagnetic Induction.
   Review magnetizing force, field intensity H, Hysteresis, magnetic polarity of a coil, motor action between magnetic fields, Induced emf, Induced current, Leng's Law, Faraday's Law of Induction.

Topic I: ALTERNATING VOLTAGE AND CURRENT

Major: Electricity-Electronics

Generalization A: Alternating current and voltage are used in AC power, audio, radio signals and inducation.

Course: Electricity-Electronics 22A

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. AC Power - generation of AC is basic to understanding of AC circuits		The student will: a. do an experiment to show how an AC sinewave of E or I is generated.	Demonstrate simple generator.	
2. Audio and Radio Signals (i.) Analysis of a generated wave helps a student understand the formulas used with the AC source		a. distinguish between audio and radio frequencies. b. observe, and analyze an AC waveform, e.g. frequency, period, wavelength, angular velocity, phase angle. c. list the different sources of AC signals - power, AF and RF generators. d. compare frequencies by means of Lissajous patterns.	Lab. 29. Lab. 31. Comparison of AF and RF generators.	
3. Compare AC to DC in Producing Power		a. interpret RMS Value, peak-value, peak-to-peak values and amplitude of an AC source. Also, draw and label a sine-wave.	Lab. 30.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
4. Ohm's Law and Power Formulas Apply Directly to AC Circuits With R Only		a. make calculations in AC electrical circuits.		
5. Kirchhoff's Laws		a. state Kirchhoff's Laws.		
		b. analyze circuits by use of Kirchhoff's Laws, Thevenin and Norton theorems.	Lab.	
6. Induction		a. explain single phase generation.	Discuss and demonstrate the phase relationship and displacement of 3-phase power generation and distribution.	
		b. explain multiphase generation.		
		c. explain three phase generation.		
		d. explain advantages and limitations of 3-phase compared to single phase.		

Notes:

Topic II: INDUCTANCE

Generalization B: The ability of a coil to induce a voltage and oppose current has a much more profound effect on the E and I in AC circuits than it does in DC.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Inductance - of a Coil		a. explain how the opposition to change is produced.	Discuss the effects of back emf as opposition to AC.	
		b. define the units of: (i.) inductance - henry (ii.) self-inductance - henry (iii.) mutual inductance - henry.		
		c. find Lt of: (i.) series connected inductances (ii.) parallel connected inductances.	Lab. 33.	
2. Phase - Inductance		a. demonstrate the effect of L in an electrical circuit. (i.) oppose change in I (ii.) cause I to lag E by 90°.		
		b. draw the I and E waveforms, vectors and phasors for circuit.		

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
3. Transformers		a. explain the three uses of transformers: (i.) step-up (ii.) step-down (iii.) isolation.	Lab. 7. Basic Electronics Lab. 48.	
4. Inductive-Reactance		a. calculate the opposition to AC $\chi^6 = 2\Pi f\imath$. b. explain how opposition to AC is produced by the back emf or counter emf of self inductance. c. calculate ind υ ctive reactances in series and parallel: $\chi\imath\tau = \chi\imath^1 + \chi\imath^2 +$ etc. in series, and $1/\chi = 1/\chi 6^1 + 1/\chi 6^2 +$ etc. for parallel. d. make calculations relative to reaction currents and voltages.	Lab. 33. Lab. 33.	
5. Coils		a. explain when a coil is considered to be a choke.	Discuss the use of L in power supply filters to try to maintain output I constant.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
6. Reactance. With Only R in an AC/ circuit there is no no reactine effect		b. discover why a choke can be used as a low pass filter because of its X_L. a. draw the waveforms and vectors for I and E. b. use the voltage triangle $E_T^2 = E_R^2 + E_L^2$. c. use the impedance triangle $Z = X_L + R^2$. d. show how R affects current in a series RL circuit and in a parallel circuit. e. demonstrate the effects of non-sinusoidal of LR circuits.	Demonstrate vectorial addition. Lab. 38. Demonstrate by the use of vectors. Lab. 39.	

Notes:

Topic III: CAPACITANCE

Generalization C: Capacitance is the ability of a component or circuit to store an electrical charge.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Capacitor Components		a. define a capacitor.	Discuss and demonstrate the structure of a capacitor.	
		b. define an electrostatic field.		
		c. differentiate between different types of capacitors eg. air, paper, mica, electrolytic, etc.		
		d. memorize the color code for capacitors.	Lab. 34.	
2. Testing		a. given a capacitor checker, check capacitors for capacitance, leakage, and power factor.	Lab. 34.	
		b. use a VOM for testing for shorted or leaking capacitors.	Demonstrate use of VOM for making the tests. Lab. 34.	
		c. discuss how the opposition to change is produced.		

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		d. demonstrate that the capacity of a capacitor depends upon: (i.) area of plates (ii.) distance between plates (iii.) nature of dielectric.		
3. Capacitors in Circuits		a. discuss and demonstrate that: (i.) series total capacitance $1/C_T = 1/C_1 + 1/C_2 + 1/C_3$ (ii.) Parallel total capacitance $C_T = C_1 + C_2 + C_3$.	Lab. 37.	
		b. demonstrate that the effect of C in an electrical circuit: (i.) opposes change in E (ii.) causes I to lead E by 90°.	Lab. 36.	

Notes:

Topic IV: CAPACITIVE REACTANCE

Generalization D: The opposition to AC by a capacitor, is capacitive Reactance $C\tau = 1/2\pi fC$ and is measured in ohms.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Capacitive Reactance		a. discuss how opposition to AC is produced by the charge and discharge of a capacitor.	Discuss opposition to AC by C.	
		b. explain that in parallel $1/\chi C\tau = 1/\chi C_1 + 1/\chi C_2 + 1/\chi C_3$ and, $\chi C\tau = \chi C_1 + \chi C_2 + \chi C_3$ in series.	Lab. 37.	
2. Ohm's Law Formula Applies to χe $\chi e = Ee/Ie$		a. make calculations relative to reactive currents and voltages.	Lab. 36.	
		b. demonstrate that because of its χc at f, a capacitor may be used as a coupling or by-pass capacitor.	Discuss and demonstrate the filtering effect of a capacitor.	
		c. differentiate when a capacitor is considered to be a coupling or by-pass capacitor because of its χc and related R.		
		d. explain why a capacitor can be used as a high-pass filter.		

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Reacting Effect		a. draw the waveforms and vectors for I and E.		
		b. use the voltage triangle $E_T^2 = E_R^2 + E_e^2$.	Demonstrate vectorial addition.	
2. Impedance		a. use the impedance triangle $Z = X_C^2 + R^2$.	Lab. 38. Lab. 40.	
3. Phase		a. show how R in a C circuit affects current in a series RC circuit and in a parallel circuit.	Discuss and demonstrate by the use of phasors or vectors. Lab. 41.	
4. Time Constant		a. demonstrate the charging and discharging rate of a RC circuit.	Discuss and demonstrate RC time constant ects. Lab. 35.	
		b. discuss the meaning of steady state voltage.		

Notes:

Topic VI: ALTERNATING CURRENT CIRCUITS

Generalization E: Reaction of coils and capacitors to AC is fundamentally different from reaction to DC.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. The Effects of L and C on I and E in an AC Circuit are Opposite		a. with the use of Vectors, demonstrate the opposite effects of L and C.		
		b. explain and calculate Z for series and parallel circuits.	Lab. 42, 43, 45, 46.	
2. Reactive Components Return Energy to Source. Watts Power		a. distinguish among, real power, apparent power, reactive power Watts, VAS, VARS.	Using Vectors, discuss the meaning of each and units of measure.	
3. Unity Power Factor is Desirable in Power Distribution. Cos $\theta = 1$		a. demonstrate that at unity power factor effects of $L(\chi_L)$ and $C(\chi e)$ cancel leaving only R in the circuit.	Discuss using Vectors and power panel if one available.	
		b. demonstrate that I and E are in phase in: (i.) a resistive circuit (ii.) RLC circuit if χe cancels χe (Resonance).		

Notes:

Topic VII: SEMI-CONDUCTOR AND VACUUM TUBE DIODES.

Generalization F: Diodes are fast-acting electronic switches with controlled conduction, conducting only when forward biased and used in detection, rectification, switching, limiting and regulations.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Semi-conductors		a. explain the electrical properties of a semi-conductor.		
(i.) Doping		b. explain the need for doping to produce extrinsic semi-conductor material.		
(ii.) PN Junction Diode		c. explain the formation of a diode.	Manual-Basic *Electronics* by Zbar. Lab. 1.	
(iii.) Biasing		d. explain Low-High resistance with forward and reverse bias.	Lab. 2, 3, 4, 5, 6.	
		e. given an ohmmeter, measure back-to-front resistance ratio and state quality of device. Test semi-conductor diodes on a diode tester.	Lab. 19.	
2. Vacuum Tube		a. explain the construction and Edison Effect of Tubes.		
		b. define biasing as the application of a voltage.		
(i.) Lumionic Emission		c. explain how electro-emission is produced by heat.		

Notes:

Topic VII: SEMI-CONDUCTOR AND VACUUM TUBE DIODES (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
(ii.) Vacuum Tube Diode. Also Used for Detection, Rectification, Switching, Limiting, and Regulation		d. explain conduction in a diode. e. test diodes on a tube tester.	Lab. 6. Lab. 19.	

Notes:

Generalization G: Power supplies convert AC to DC through rectification, filtering, and regulation.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Rectification		a. explain how a diode can be used as a rectifier and explain: (i.) how a half-wave rectifier operates (ii.) how a full-wave rectifier operates	Lab. 8, 10.	
		b. given components and schematic, assemble each rectifier in turn.		
2. Filtering		a. observe the effects of filtering on DC output.	Lab. 9.	
		b. compare the effectiveness of various filter arrangements.		
		c. compare filtering effects of half-wave and full-wave rectification.		
3. Regulation		a. define regulation and distinguish between good and poor regulation.		

Notes:

Topic VIII: POWER SUPPLIES (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		b. discuss different devices for regulation. c. given load and no load voltages, calculate % regulation. d. compare the regulation of a full-wave and half-wave power supply.		

Notes:

Topic IX: TRANSISTORS

Generalization H: Transistors are current operated doped semi-conductor solid-state amplifying devices whose parameters are determined by circuit arrangement and electrode biasing. Transistors are replacing vacuum tubes in most electrical-electronic equipment.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Transistors Familiarization		a. explain different transistor basing.	Lab. 13.	
		b. observe the effects on emitter-base current of forward and reverse bias.		
		c. memorize the laws of transistor biasing.		
2. Parameters Alpha ∝ Beta ß		a. observe the effect on Ic of varying Ie.	Lab. 14. Lab. 15.	
		b. calculate the current gain of a common base configuration - alpha.		
		c. observe the effect on Ic of varying Iß.		
		d. calculate the Beta gain of a common emitter configuration.		
3. Transistor Testing		a. test transistors with an ohmmeter and a transistor tester.	Lab. 19.	

Notes:

Topic IX: TRANSISTORS (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
4. Transistor Amplifier Configurations CE, CB, CC		a. demonstrate biasing methods for each configuration. b. observe and explain the effects of stabilization. c. compare the input and output impedances of different configurations. d. observe and discuss the phase relationships of the signal voltage in the amplifiers.	Lab. 23, 24, 25, 26. (possibly only time for CE) (Lab. 23).	

Notes:

Topic X: ELECTRON TUBES

Generalization I: Electron tubes are voltage operated amplifying devices in which thermionic emission of electrons flowing through the tube could be controlled by charged grids.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Dynamic Characteristics of Tubes		a. observe the transfer characteristics of a tube.	Lab. 16.	
		b. become acquainted with the use of a tube manual.		
		c. test tubes.	Lab. 19.	
		d. explain the tube parameters of a triode-transconductance, amplification-factor, and effect plate resistance.	Lab. 14.	
2. Amplification. How and Why a Tube Amplifies Triodes, Tetrodes, Pentodes		a. observe and be able to explain why and how a tube amplifies.	Lab. 20.	
		b. observe and discuss distorted signals and causes of it.		
3. Tube Troubles		a. list tube troubles and ways to check them.		

Notes:

VI. ELECTRICITY-ELECTRONICS

3. Electricity 22B

Residential Wiring

INTRODUCTION

Electricity 22B introduces the student to basic residential wiring. The introductory course, Electricity-Electronics 12 or 12A should be a pre-requisite. Students will find the 22A very helpful if taken early in the sequence, especially if they intend to complete the full Electricity program.

REFERENCES

Prime References

Graham, U. C. *Interior Electric Wiring.* American Technical Association, Chicago. 6th Ed.

Canadian Electrical Code. Current or latest approved edition. C.S.A.

Lister, E. C. *Electric Circuits and Machines.*

Long, F. J. *Intermediate Electricity.* 1965 Ed.

Jennings, W. H. *Canadian Law.* Ryerson Press.

Up-to-date supply catalogues - G.E., Federal Pacific, Westinghouse, Sylvania, S & S, etc.

Secondary References

Miller, Rex & Culpepper, Fred W. Jr. *Energy.* McKnight & McKnight Pub.

Shoultz, U. C. *Basic Electricity.* Macmillan of Canada, Ltd.

Lewis, J. L. & Weafford, P. E. *Electric Currents.* Longman Canada Ltd.

"How to Run a Business" "Doing Business" series. Canadian Govt. Booklets. Dept. of Industry

Career Field: Electricity-Electronics

Topic I: CAREER OPPORTUNITIES IN ELECTRICITY

Major: Electricity

Generalization A: A knowledge of the career opportunities in electricity will help the student make a more rational choice of school courses that prepare him for a future job.

Course: Electricity 22B (Residential Wiring

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. The Career (i.) Residential wiring is only a small facet of the electrical field (ii.) Commercial wiring must be taken to be eligible for "time-off" on apprenticeship		The student will: a. investigate the career opportunities in the electrical field by: (i.) listing the number of jobs available in the home location (ii.) interviewing electrical firms. b. study the Apprenticeship Act of Alberta and list its requirements.	Discussion. Career film. Visit by power company official, etc. Lecture/Discussion with aid of government brochures.	

Notes:

Topic II: SAFETY

Generalization B: Safety is of prime importance to the well being of persons and equipment.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Unsafe Act		a. list the consequences of acts in electricity particularly as they relate to: (i.) electric wires (ii.) wire loads (iii.) pounding procedures (iv.) climbing harness		
2. Unsafe Condition		a. discuss how to identify conditions which could lead to injuries on the job.		
3. First Aid		a. perform artificial respiration b. test for shock		

Notes:

Topic III: INSTALLATION OF RESIDENTIAL WIRING

Generalization C: The function of residential wiring is to provide proper, safe and sufficient power distribution in the home so that it can be efficiently utilized.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Installation				
(i.) Code		a. explain the need for the Code and demonstrate his knowledge of the contents of the code book by finding sections requested by the teacher.		
		b. given the plan of a home, "wire" it according to the regulations governing such and pass inspection by a government inspector.	Discussion with aid of "information sheets" on sections 0, 2, 4, 6, 8, 10, 12, 16 and 30 of the Code.	
2. Planning				
(i.) Symbols are the shorthand of drafting		a. use the electrical symbols, especially those used on residential plans: lights, outlets of various sorts, homeruns.	Starting with simple circuits students would progress through a series of worksheets to more "complex" circuits.	
(ii.) Blueprints are the medium by which ideas become practical		b. identify and interpret.	Lecture/Discussion	

Notes:

Topic III: INSTALLATION OF RESIDENTIAL WIRING (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
(iii.) Orthographic Drawing		a. plan, layout and draw side, top and front views of objects.		
3. Tools		a. given a tool, describe where it is used, how it is maintained, how it is adjusted and safely used.	Lecture/Discussion. Films by Gen. Motors.	
		b. use special handtools and trouble shooting equipment with some proficiency.	Exercises can be provided so that a student will gain first hand knowledge on how to use and apply them in residential wiring. (Tables 2 & 3)	
		c. show proper and safe use of equipment such as ladders, stud guns and various electrical tools.	Lecture/Demonstration. Films. Table 4.	
4. Power Outlets				
(i.) Voltage and current ratings are prescribed by the CEC for wire sizes, circuits, and components		a. given an electrical component, identify its various ratings.	Discussion/Demonstration. Use actual components and refer to the appropriate code ruling to determine its overall characteristics.	

Notes:

Topic III: INSTALLATION OF RESIDENTIAL WIRING (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
(ii.) High usage areas require special circuit arrangements		b. lay out circuit arrangements according to Code in such areas as the kitchen, utility area, and dining room. c. plan approved alternatives to the above, such as: - load centres - split receptacles - ganging of recept.	Discussion of Code and its applications. Practice in circuitry could be accomplished by having the student draw the circuits.	
(iii.) Special wiring is a requirement for high-wattage appliances such as: range, dryer, and dishwasher, etc.		d. given the appliance rating in watts, translate this in terms of wire size, breaker size, etc. according to Code. e. prepare a material list for a general installation.	Lecture/Discussion . In lieu of practical work, worksheet could be used.	
5. Lighting		The student will explain in detail Section 30 of the C.E.C.	Discussion on Sect. 30, C.E.C.	
(i.) Wiring of fixtures must allow for characteristics of fixture			Students can be given the opportunity to install a special fixture according to the rules of the Code. e.g. Use of armored cable, heat resistant wire, etc.	

Notes:

 Topic III: INSTALLATION OF RESIDENTIAL WIRING (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
(ii.) Flourescent fixtures should be used where a high, even concentration of light is desired		a. explain the features of flourescent lighting by being familiar with its operation and associated characteristics.	Lecture/Discussion. Films from Gen. Electric. A flourescent fixture could be examined and wired. A comparison between incondescent and flouresscent lighting taking into account candlepowers, lumins, watts, etc., could be made and highlighted by the use of light sensitive measuring equipment.	
6. Services		a. sketch a complete service that will meet Code requirements.	Lecture/Discussion/Demonstration. Activities to include, if possible, work on actual service equipment. Referral to Sect. #6 of the C.E.C. and Tables 2 & 5 is a necessary part of this activity.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
(i.) Breaker: provide over-current protection		b. explain what protection is provided by: (i.) main breaker (ii.) branch circuit breakers.	Discussion/Demonstration. Students should be able to work on a panel, i.e., installation wiring and tying in breakers.	
7. Special Circuits				
(i.) Transformers are a convenient method by which voltages can be stepped down		a. write an essay on how transformers are installed and why they are used.	Discussion. Students can be given the opportunity to work with transformers and realize at the same time why they are used in bell circuits, remote control circuits, and furnace control circuits.	
8. Garages		a. given a garage layout, the student will be able to wire it internally and service it by either: (i.) underground or overhead feeder	Lecture/Demonstration. The student can be given a lot layout showing a house and garage location and be required to draw in the wiring circuits.	

Notes:

Topic IV: MAINTENANCE

Generalization D: Efficient and safe operation of the residential wiring system depends on regular and effective maintenance.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Gas Furnace Heating		a. explain how furnace electrical components perform their functions and how they are used as control devices in either the primary or secondary circuit. e.g. limit switches thermocouples thermostats.	Lecture/Demonstration. Students can be given exercises and practice work with the components (maintenance of motors)	
(i.) All heating systems must be provided with an internal protection circuit		b. draw and explain the operation of a control circuit.	Lecture/Discussion with pertinent information from Sect. #62, C.E.C. of at least one heating system.	
2. Electric Heating		a. describe the various types of electrical heating e.g. - baseboard - underground.	Discussion with application of Section #62, C.E.C.	
3. Rewiring				
(i.) additional outlets		a. fish in an additional outlet without major damage to a partition or ceiling.	Discussion. Student can be assigned to fish in an outlet in a mock-up.	
		b. demonstrate ability to use special equipment such as collapsable boxes & fish tape.		

Notes:

Topic V: MANAGEMENT PRACTICES

Generalization E: An understanding of relationships between employer and employee, unions and management and regulations that bind both is essential to help all concerned meet their responsibilities.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Business Organization and Procedures		a. discuss in an intelligent manner different types of businesses, laws that regulate them and some advantages/disadvantages of each.	Lecture/Discussion about the formation and running of companies in Alberta. Govt. of Alberta pamphlets can be obtained on this.	
		b. discuss the methods of invoicing, stock taking, billing, collecting tardy accounts.	Discussion. Develop with examples.	
		c. Workmens Compensation responsibilities.		
2. Bidding on work		a. given a residential blueprint, submit an accurate bid.		
3. Employee Concerns				
(i.) The interests of the worker are protected by various means. Legislation		a. discuss the responsibilities in contributions towards; U.I.C., pension, medical.	Discussion.	
(ii.) Employee groups		b. discuss the various employee groups, advantages and disadvantages and his expectations in his area of domicile.		

Notes:

VI. ELECTRICITY-ELECTRONICS

4. Electricity 22C

Appliance Service

INTRODUCTION

Electricity 22C is a five-credit module in appliance servicing which students can advance to from Electricity-Electronics 12.

REFERENCES

Repair Manuals.

Topic I: SERVICE EQUIPMENT

Major: Electricity

Generalization A: A knowledge of the use and handling of service equipment is basic to the service man.

Course: Electricity 22C (Appliance Service)

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Care and organization of equipment is necessary for successful work		The student will: a. given a set of equipment, organize it and take care of it.		
(i.) Hand tools		b. given the required hand tools, use the tools for specific purposes explained by the teacher: (i.) screwdrivers (ii.) wrenches (iii.) pliers (iv.) other.		
(ii.) Meters		c. given a variety of meters, demonstrate their functions: (i.) voltmeter (ii.) ammeter.		
(iii.) Specialized equipment		c. given specialized equipment (iron temperature testing stand, timer tester, specific assembly tools), use them for their designed purposes.		

Notes:

Topic I: SERVICE EQUIPMENT (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
2. Service Information		a. given any appliance for repair, find service information relative to it.	Use a service text.	

Notes:

Topic II: TROUBLESHOOTING

Generalization B: A knowledge of troubleshooting is basic in servicing.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Safety				
(i.) Unsafe act		a. list the consequences of unsafe acts in appliance servicing as they relate to: (i.) live circuits (ii.) overloading (iii.) instrument use (iv.) grounding procedures (v.) lifting.		
(ii.) Unsafe condition		b. discuss how to identify conditions which could lead to injuries on the job.		
(iii.) First aid		c. perform artificial respiration.		
		d. treat for shock.		
2. Cleaning Appliances		a. explain the destructive role of dirt in mechanical breakdown.		
		b. inspect and clean a toaster (or other appliance)		

Notes:

 Topic II: TROUBLESHOOTING (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
3. Circuit Failures		a. given an appliance, test for circuit continuity. b. repair faulty circuits.		
4. Material Failures		a. given the names of commonly used materials for manufacturing appliances and insulation, identify probable locations of breakdowns.		
5. Other Causes of Failure		a. discuss and list contributing factors to appliance failure.		

Notes:

Generalization C: There is a most effective technique in servicing.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Service Records		a. record all the data he requires in a repair operation.	From the nameplate of a motor, copy all the manufacturer's data, and connection diagram.	
2. Dismantling		a. given any appliance, dismantle it in accordance with a standard procedure.	Study the best way to dismantle an electric steam iron.	
3. Cleaning an appliance		a. clean any given appliance.	Clean the vents and soleplate of an electric steam iron.	
4. Adjustments		a. given an appliance that needs only adjusting, perform the required operation.	Adjust the high temperature setting on a steam iron.	
5. Repairing		a. make repairs on power and explain.	Repair a power cord which has lost its circuit.	
6. Making Replacements		a. explain when to repair and when to replace.	Given a burned terminal on a wire, replace the terminal.	
7. Reassembly		a. after he has disassembled an appliance, reassemble it according to the standard procedure.	Have a student reassemble a steam iron after he has taken it apart.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
3. Testing		a. test a repaired power cord.		

Notes:

Topic IV: ESTIMATING AND PRICING

Generalization D: A knowledge of estimating and pricing is necessary in servicing.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Overhead Expenses		a. list the costs that go into overhead expenses.	Student will try to estimate the monthly cost of going to work on a job.	
2. Parts Pricing		a. write a summary of why a part cannot be sold at the invoice price.		
3. Cost of Labour		a. compare estimated price with final price.	Estimate the cost of replacing thermostat in iron: then replace it and write a final price.	
4. Standard Pricing		a. explain why a standardized system is set up.	Find an example of standardized pricing for the appliance trade or others.	

Notes:

Topic V: TRADE SUPPLIES

Generalization E: Trade supplies must be available and economical.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Distribution Centres		a. list agents for various repairs.	In the phone book locate a supplier who represents a manufacturer.	
2. Manufacturers Policies		a. discuss parts policy.	Identify situations in which service or repair parts are unavailable. Analyze the underlying causes and suggest possible solutions.	
3. Trade Names		a. discover that competing mechanisms are actually under the control of one firm.	Student looks for examples of very similar products.	
4. Parts Made by Jobbers		a. discuss time limits for patent rights.	Look through a supply catalogue that has not been issued by original manufacturer.	

Notes:

Generalization F: There are several factors to consider in becoming a tradesman.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		The student will:		
1. Trained Service Personnel Have Choices Where They May Work		a. discuss the ways in which he may use his talents.	Make a list of job opportunities that should be available.	
2. Working As An Employee		a. list the advantages and disadvantages of working for an appliance firm in this city.		
3. Operating a Private Business		a. list the pros and cons for a private business.		
4. Recycling Products		a. list all possible factors concerned if recycling should become a practise.		
5. Servicing Your Own Appliances		a. list all the appliances used in a home. Consider the service life of the various appliances.		

Notes:

VI. ELECTRICITY-ELECTRONICS

5. Electricity 32A

Commercial Wiring

INTRODUCTION

The module in Commercial Wiring may be in sequence or students may advance to it directly from Electricity-Electronics 12.

The objectives of this course are:

1. To provide the students with fundamental skill and knowledge required in electrical construction and to familiarize them with tools, fittings and equipment used in industry.

2. To provide a background of Electrical Code regulations so that a student may understand the reason for various restrictions and regulations and so that he may develop a standard of performance that would enable him to enter the electrical construction field upon completion.

3. To introduce a student to the various systems used in providing electrical outlets of all types in large residential, commercial and industrial installations.

4. To familiarize the student with the specialized terminology and equipment of the domestic and commercial heating controls field.

This course could be taught in almost any electricity lab or shop, but could best be done in one equipped with a large wooden "mock-up" structure with open frame and sheeted walls on which a variety of electrical installations can be placed. Use of "heavy construction" areas or "pipe trades" areas would be advantageous. It is expected that the instructor would provide about half of the time for practical work for his students, with the remaining time devoted to discussion of wiring practice, theory and related code.

Because of the rather limited time available, it is suggested that printed hand-outs and programmed instruction be used as much as possible.

Time allotted for each topic area is approximate only and would vary with types of equipment (e.g. heating systems) available.

No expensive equipment is required for this course, although supplies of conduit and wire, which have limited re-use possibilities, may be fairly extensive.

Safety

Safety is to be an integral part of each lab or shop activity. Proper, safe physical facilities must be provided, as well as a good example set by the teacher which will influence a student's attitude in a positive way toward safe behavior.

Industrial safety films from such organizations as the Alberta Workmen's Compensation Board should be used throughout the year, on a continuing basis. The dual purpose here is to show possible hazards and safe procedures in industry, as well as school, so that a student will not only observe safety procedures and have a proper attitude in school, but also that he may be made aware of the requirements in the field and thus be far less likely to suffer an accident in the most dangerous period - his first few months on the job.

The 1971 IAVEC Industrial Safety booklet is an excellent guide for the program.

Career Information

The teacher is, of course, expected to keep in close contact with industry, and should have discussions with students about possible employment in all areas related to the 5-credit module. Discussions should cover employer practices, requirements, unions, working conditions, wages, reports, forms, time sheets, etc. Representatives from employers, unions and Government agencies should be encouraged to visit and to present their information and viewpoints to the students.

Field trips are extremely important, if properly organized and, of course, provide a great deal of career information as well as motivation for the student.

REFERENCES

Canadian Electrical Code - CSA - 10th edition.

Electrical and Electronic Technology - Browers (Book I and II), General Publishing, Don Mills, Ontario.

Electrical Construction Wiring - Alerich - General Publishing, Don Mills, Ontario.

American Electricians Handbook.

Up To Date Catalogues (supplies) - Westinghouse
- General Electric
- Square D
- Federal Pacific.

Topic I: TECHNICAL DRAWING

Major: Electricity

Generalization A: Provincial and Residential wiring requires detailed sets of drawings, building plans and wiring diagrams.

Course: Electricity 32A (Commercial Wiring

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Schematic electrical drawings		The student will: a. draw a complete electrical circuit showing all connections and components (symbols) given a description of the circuit and its components.	These should be based on active circuits students are working on in lab experiments.	
2. Plan views		a. relate the various outlets in an actual building mock-up to the scaled locations on a "top view" drawing.	Actual wiring projects, commercial and residential should be transferred to various scale plan drawings.	
3. Dimensioning		a. correctly use an architect's scale and various drawing templates. b. draw portions of buildings to scale and show various necessary measurements.	Various exercises on scaling, using all common scales. Transferring measurements from drawings to other drawings of a different scale.	
4. Architectural Electrical Mechanical		a. use each set of drawings as they specifically apply to an electrical installation.		

Notes:

 Topic I: TECHNICAL DRAWING (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		b. interpret the drawings to obtain complete information regarding location and installation of an electrical system.		

Notes:

Generalization B: A wide assortment of conduit, ducts, cables, fittings and boxes and equipment are required in commercial electrical installations.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Raceways		The student will: a. discuss methods of installation of each type of raceway. b. measure, bend and fasten electrical materials. c. follow a plan drawing to locate and install representative portions of each system.	1. On small frame or block "mock-up" areas. Students should complete various projects which will allow them to make bends, take measurements, etc. 2. After completion of basic skills in this area, larger projects should be made available. Electrical installation in a "live" project, such as heating, lighting and ventilation systems (in conjunction with a pipe trades shop for example). 3. Installation of a conduit system for lighting, power, heating, etc. in a "refundable type" of project - such as a portable school classroom.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
2. Conductors		The student will:		
(i.) See Section 12, CEC Rules regarding various raceways, cables and ducts		a. use code tables to determine proper conductor size for various loads. b. calculate ampacity for conductors when there are 4, 5, 6, 7, 8 and 9 conductors in a raceway.	Same Activities as in wiring methods.	
3. Tools and Equipment		a. take proper care of the various tools and instruments. b. make large and small off-sets and 90° bends in rigid pipe and EMT. c. drill brick or concrete and install the proper fasteners.	Construction of major project.	
4. Fittings and Boxes		a. select the proper boxes and fittings on a commercial lighting installation, a heating or ventilating system and install and fasten them in a manner approved by code and standards of good workmanship.	Construction of major project.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
5. Hazardous areas		a. discuss various categories of safety areas required. b. recall the appearance of some of the basic explosion-proof, vapor proof fittings.	No installation required, only familiarization.	

Notes:

Generalization C: Proper service size, conduit, conductors, panels, breakers must be calculated for each commercial or residential installation and code regulations must be followed.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Service Entrance		The student will:		
(i.) Overhead service		a. list all the fittings required: (i.) for a 100 amp. service with main breaker, range and dryer breakers and 15 amp. circuits; panel located in basement and meter outside, with mast pole.	Services to be installed on building mock-up.	
(ii.) Underground residential and commercial service		b. as above for 2 motor commercial installation 200 a. Same as above with an underground service entrance.		
2. Metering equipment		a. describe the various types of energy meters: (i.) 2 and 3 wire KWH meter (ii.) 3 phase meter (iii.) demand meter b. install various types of meter sockets.		

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
3. Protective equipment (i.) Fuses (ii.) Air-circuit breakers (iii.) Panel Boards (iv.) Unit Sub-stations		a. describe various fuses and breakers and code requirements. b. list advantages and special uses of each device.	Practice installation of breaker panels, fuse panels and study existing school main panels and unit substations. Visit construction sites.	
4. Metering Regulations		a. read Section 6 of the Code, with an emphasis on: (i.) large domestic, small (ii.) commercial services (iii.) complete metering equipment.		
5. Demand Factors		a. calculate total service for a residential installation, taking into account square footage and specific electrical appliances and equipment as a multi-residential installation. b. calculate feeder size, given the square footage of each unit and specific equipment for each. c. calculate service size on apartment with 10 suites, 20 suites, etc.	Calculation to be done for various sizes, domestic and commercial buildings.	

Notes:

Generalization D: Installation of Motors and Controls requires a thorough understanding of motor protection devices and a knowledge of remote control relaying.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Protection and Control (i.) single phase (ii.) 3 phase		The student will: a. list various protective devices and control devices required for 1/4 to 1/2 H.P. 1 phase motors and calculate the exact heater protection required. b. list the various types of motor protection commonly used for 3-phase motors. c. describe the various control systems using 2 and 3 wire control, selector switches (hand, off, automatic, etc.) d. select the proper heater size and starter size for a given motor.	Install a 1 phase, 1 pole motor starter a/w heater for motors 1/4, 1/3, 1/2, and 3/4 H.P. on plywood mock-up board. Install various type and size of 3 phase motor starters, and wire a variety of control systems to these on a plywood mock-up board. Connect to various 3 phase motors.	
2. Relays, solenoids, starters, limit devices		a. select sets of control devices that will do the following: (i.) stop and start a motor using N.O. and N.C. relays in a basic 2 wire control	Connect on a plywood module a standard set of controls in a manner as similar as possible to an actual commercial installation using EMT, flex and TW wire.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		(ii.) stop and start a motor with limit switches on a 3 wire control (iii.) operate a 3 motor in a forward or reverse direction (iv.) allow a 2 speed motor to be run on either speed at the operation of a low-high push button.		

Notes:

Topic V: INSTALLATION OF EQUIPMENT

Generalization E: Installation of electrical equipment must be made according to the Canadian Electrical Code.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Lighting equipment (i.) Homes (ii.) Offices (iii.) Commercial areas		The student will: a. install correctly the following: (i.) incandescent surface switch (ii.) fluorescent (iii.) recessed fixture b. describe grounding methods used on portable equipment.		
2. Special equipment		a. make installations in compliance with code rules of the following: (i.) appliance receptacles (ii.) dryers (iii.) ranges (iv.) circuit breakers	See Topic 2, Section 26, Canadian Electrical Code.	
3. Grounding		a. interpret Section 10 with respect to grounding of systems and services. b. list methods of grounding fixed equipment.	Install proper grounds on project.	

Notes:

Generalization F: Heating systems require a variety of low voltage and extra low voltage controls to maintain proper temperature and ventilation and to provide safety from gas or steam explosions.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Power supply		The student will: a. describe the operation of: (i.) 24 volt transformers (ii.) powerpile generators using pilot flame.	Residential furnaces (if pipe trade shop available, actual gas convertors can be made and live operation accomplished).	
2. Controls				
(i.) Thermocouples		a. describe the operation of: (i.) a thermocouple - thermocouple relay and connection to gas valve. (ii.) high output "power pile" used to "power" gas valve.	"	
(ii.) Thermostats		b. describe the operation of various types of thermostats: (i.) 2 wire (ii.) 3 wire line voltage (iii.) extra low (MV) voltage.	Connect actual thermostats.	
(iii.) Fan control		c. describe how fan controls and limit switches operate: (i.) wire low voltage and extra low voltage control.	Use standard controls, make all connections.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
(iv.) Hot water systems require special controls		d. describe the: (i.) pump system (ii.) hot water boiler (iii.) control.		
3. Steam heating systems		a. describe the operation of pressure control, low water cut-off, water level controls, stack relay in a steam heating system.	Actual boiler if P.T. available. Otherwise connect controls to dummy boiler - simulate operation. Study school boiler system.	

Notes:

VI. ELECTRICITY-ELECTRONICS

6. Electricity 32B

Electro-Mechanical

INTRODUCTION

This module on Electro-Mechanical Systems may be taken following completion of Electricity-Electronics 22A.

The objectives of this course are:

1. To introduce the student to all forms of rotating electrical machinery including the principles of operation and electrical theory and calculations.

2. To provide the student with opportunities to work with large and small A.C. and D.C. generators and motors and to gain an understanding of the characteristics of each by a series of experiments and work projects.

3. To provide the proper technical skill and knowledge for those students who may decide to proceed further into the challenging field of electrical technology. This course should enable a student to find out if he has the ability and interest to proceed in a technology.

This course will also provide a helpful background for the student planning a career in the apprenticeship area, if taken in conjunction with, or in sequence with the residential and commercial wiring courses.

Times allotted for each area are approximate only.

The total amount of work involved in each area will depend on the type of equipment available. Laborous, slow switching from motor to generator, etc. should be avoided. There is no time for it. This particular unit lends itself very well to individualized instruction, with students proceeding at various rates through the course, using prepared hand-out materials, several reference books, programmed learning units, where available. Students will, hopefully, be conducting various labs and work projects at different times, allowing a lab to operate quite effectively using only one or two units of each type of machine.

Safety

Safety is to be an integral part of each lab or shop activity. Proper, safe physical facilities must be provided, as well as a good example set by the teacher which will influence a student's attitude in a positive way toward safe behavior.

Industrial safety films from such organizations as the Alberta Workmens' Compensation Board should be used throughout the year, on a continuing basis. The dual purpose here is to show possible hazards and safe procedures in industry, as well as school, so that a student will not only observe safety procedures and have a proper attitude in school, but also that he may be made aware of the requirements in the field and thus be far less likely to suffer an accident in the most dangerous period - his first few months on the job.

The 1971 IAVEC Industrial Safety booklet is an excellent guide for the program.

Career Information

The teacher is, of course, expected to keep in close contact with industry, and should have discussions with students about possible employment in all areas related to the 5-credit module. Discussions should cover employer practices, requirements, unions, working conditions, wages, reports, forms, time sheets, etc. Representatives from employers, unions and Government agencies should be encouraged to visit and to present their information and viewpoints to the students.

Field trips are extremely important if properly organized and, of course, provide a great deal of career information as well as motivation for the student.

REFERENCES

Electrical and Electronic Technology. Browers - General Publishing, Toronto, Ontario.

Electrical Machines. Siskind - McGraw-Hill, Toronto, Ontario.

Electrical Motor Controls and Circuits. Fuchs and Garstang - Sams Publications.

Basics of Fractional Horsepower Motors. Schweitzer - Rider Publications.

Controllers for Electric Motors. James and Markle - McGraw-Hill, Toronto, Ontario.

Lab Manuals - Select according to equipment purchased.

- *Unitic Unelco*
- *Edupak*
- *Electro-Lab, etc.*

Topic I: BASIC GENERATOR Major: Electricity

Generalization A: Induced EMF is caused by passing a conductor through a magnetic field. Course: Electricity 32B (Electro-Mechanical)

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Basic AC generator		The student will: a. disassemble and reassemble complete DC generator	Demonstrations with small single one coil generators.	
2. Eddy currents		a. describe the effect of eddy currents.		
3. Generator fields		a. connect DC generator fields in all of the configurations.		
4. Induced EMF		a. calculate induced EMF for various generators.		
5. Inter-poles		a. connect interpoles on generators and by diagrams, for 2 and 4 pole generators for: (i.) clockwise rotation (ii.) counter-clockwise rotation.	Actual shop operation of various DC generators. Connection of field winding, interpoles, etc.	
6. Generator characteristics		a. run speed tests of generators at various loads and make comparisons.		

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
7. Efficiency		a. calculate efficiency of a DC generator given power output and voltage and current input. b. calculate voltage regulation of various DC generators given voltages at varying loads.		

Notes:

Generalization B: D.C. Motors have unique characteristics that are still advantageous over other types of electric motors in certain applications.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Development of torque		The student will: a. describe the principle of a DC motor. b. calculate torque, CEMF, etc. c. demonstrate various applications.		
2. Series field		a. list advantages of series field. b. describe principle of series field motor. c. recognize this type on actual motor. d. connect fields - know characteristics of shunt field and advantages.	Dismantle and reassemble. Run tests of various types.	
3. Shunt field		a. describe shunt field motor.		
4. Compound motor		a. describe compound motor b. list advantages and applications.		
5. Armature reaction		a. calculate whether interpole would be a N or S pole.		

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		b. connect interpole windings using correct polarity.		
6. Starters		a. connect up various starters - manual and automatic.		
7. Speed control		a. choose appropriate speed control and make proper connections. b. connect up various motor speed controls, including silicon controlled rectifiers.		

Notes:

Topic III: A. C. GENERATORS

Generalization C: The A.C. generator is studied as an electrical machine of major importance in its own right, as well as a means of analyzing sine wave forms of voltage and current.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Two pole basic generator		The student will: a. disassemble and assemble small generators. b. examine various types of rotating armature, rotating field.		
2. Rotating field		a. check and examine slip rings and brushes. b. study various exciter systems and controls. c. list advantages of this type of construction.		
3. Voltage regulation		a. operate alternator. b. calculate performance, characteristics.		
4. Three phase generator		a. list advantages.		
5. Parallel operation of generators		a. synchronize two generators. b. shift load from one to the other.		

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		c. understand the effect of over-exciting generator when paralleled. d. parallel two alternates using 3 lamp dark method.		

Notes:

Generalization D: The A. C. Motor is studied as an electrical machine of major importance in its own right, and also as a means of understanding sine wave forms of voltage and current for single phase and 3 phase systems.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Two phase and 3-phase systems		The student will: a. connect the stator windings of a 3-phase motor in a Y or delta configuration to the line. b. describe the construction of the stator, rotor endframe, etc. and be able to disassemble and assemble complete motor. c. reverse the direction of the rotating field. d. overcome the effects of "single phasing". e. explain the torque characteristics of a 3-phase induction motor.		
2. Wound rotor		a. describe the difference in connection and operating characteristics between squirrel-cage rotors and wound-rotor types. b. make torque, speed efficiency tests on shop units connected to variable loads.		

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
3. Single phase induction motor		a. disassemble and reassemble complete unit. b. describe split phase principle, purpose and operation of centrifugal switch. c. draw diagrams of internal parts - switches, thermal protection, etc.		
4. Capacitor start split-phase motors		a. make proper connections to run and start windings for various types of single speed and dual speed motors, single and dual voltage. b. record name plate date. c. operate motor at all name plate speeds and voltage.		
5. Motors (i.) Basic construction (ii.) Synchronous motors		a. describe the basic differences in principle and in motor construction between the basic induction motor and the synchronous motor. b. explain the controls used on the D.C. field of the synchronous motor.	3-phase synchronous motor to be operated with various settings of field rheostat. Motor to be loaded until it drops out of sync. Readings to be made of speed, field current, torque and stator current.	

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
(iii.) Self-Synchronous		c. apply basic principles of sync. motor to self-synchronous systems by connecting and operating them.		
(iv.) Shaded Pole motors		d. recognize the specific type of motor and perform basic trouble-shooting procedures and repairs.		
(v.) Series or "Universal" motors		e. work with various sizes of universal motors. Disassemble, etc. Commutator dressing and polishing, brush replacement.		
		f. Use growler.		
6. Manual and Magnetic Motor Starters		a. wire up various motor starters, connecting them to single phase and 3-phase motors.		
		b. draw detailed schematic diagrams of these.		
		c. reverse starters.		
		d. calculate size of heater required for proper motor protection.		
		e. draw schematic diagrams of all of the above.		

Notes:

 Topic IV: A.C. MOTORS (Continued)

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
7. Relays, interlocks, timers and transducers		a. connect a variety of control devices to motor circuits which have already been wound to magnetic starters.		

Notes:

Generalization E: Mutual induction will cause one coil to induce a voltage in another when they have a common magnetic field.

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
1. Ampere turns		The student will: a. define the concept of ampere turns.		
2. Voltage and current ratios are directly related to turns.		a. calculate voltages and current using transformer ratios. b. measure primary and secondary voltage and currents on a loaded transformer. c. describe principles of transformer losses of large and small transformers. d. perform tests calculating core losses and losses. Calculate efficiency.		
3. Paralleling transformers		a. perform a paralleling operation with 2 transformers of unknown polarity. b. check transformers for polarity using: (i.) voltmeter (ii.) oscilliscope (iii.) "kick" test.		

Notes:

Generalization

Concept and Sub-Concepts	Approx. Time	Behavioural Objectives	Activities or Jobs	Resources
		c. calculate current from each power rating required of each under specific load.		
5. Specific function transformers		a. explain the principle of and proper methods of connecting and using: (i.) auto transformer (ii.) instrument transformer - current transformer - potential transformer (iii.) variable transformer (iv.) isolating transformer. b. connect and operate under realistic load, the transformer types listed.		

Notes:

VI. ELECTRICITY-ELECTRONICS

7. Electricity 32C

Industrial Electricity-Electronics

INTRODUCTION

The final module in the Electricity sequence is available to students who have completed 30 credits or six modules in the major.

The 125 hours of instruction time in this module may be used to:

a. provide greater depth to a module taken previously. Individual students, groups of students or whole classes may elect to study an area in more detail. The in-depth study could be in residential wiring, appliance servicing or any of the other modules listed in the sequences.

   The time could also be spent in developing the topic of Industrial Electricity-Electronics. Content for this module has not been structured and the teacher would have to do this himself.

b. engage in actual wiring or electrical repair work by means of a program co-ordinated by the Electricity teacher and under the supervision of a journeyman on the job.